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Nickles

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[54] **NETWORK SECURITY AND INTEGRATION METHOD AND SYSTEM**

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[73] Assignee: **Client/Server Technologies, Inc.**, Alpharetta, Ga.

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[51] **Int. Cl.**[7] **G06F 15/16**

[52] **U.S. Cl.** **709/229**; 709/225; 709/217

[58] **Field of Search** 395/200.47, 200.49, 395/200.56, 200.59, 187.01, 186; 709/203, 204, 205, 217, 219, 225, 229, 230, 246, 206; 380/21–25, 29, 30; 713/200, 202

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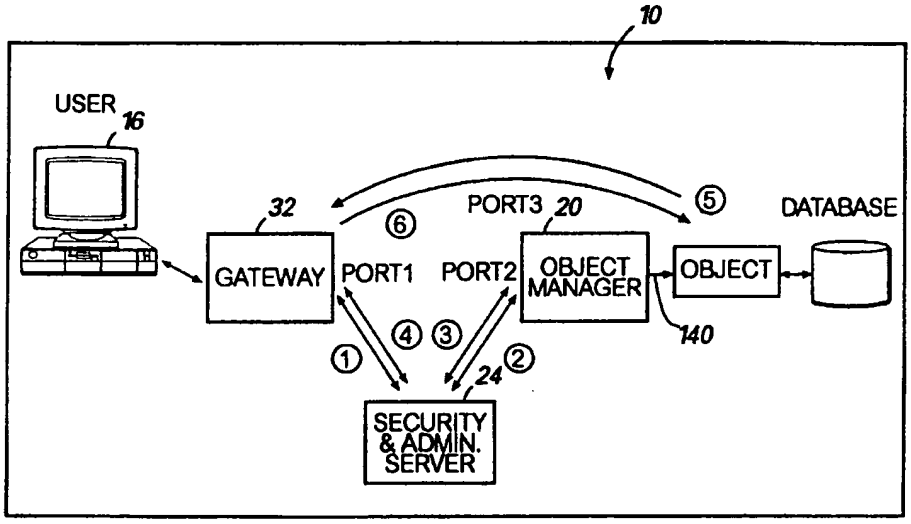
Primary Examiner—Mehmet B. Geckil

Attorney, Agent, or Firm—Morris, Manning & Martin, LLP

[57] **ABSTRACT**

A method of the present invention includes a network security system that has a single point of access control to a source computer system. The network security system provides various mechanisms for securing access to a source computer systems that includes generating single-use encryption keys, generating random port assignments for communication between devices, an asynchronous message protocol used in the security system and utilizing various levels of transaction tables to help secure and manage security parameters of the system. More particularly, the present invention provides a method for securing access to a plurality of computers connected via a network. An indication is received that a first user of a first computer program module desires to communicate with a destination computer system. When this indication is received, a message is directed to a security computer system. The security computer system determines whether the first user is authorized to access the destination computer program module of the destination computer system. If the security computer system determines that the first user is authorized to access the destination computer system, the security computer system sets up a communication protocol between the first computer program module and the second computer program module.

20 Claims, 10 Drawing Sheets



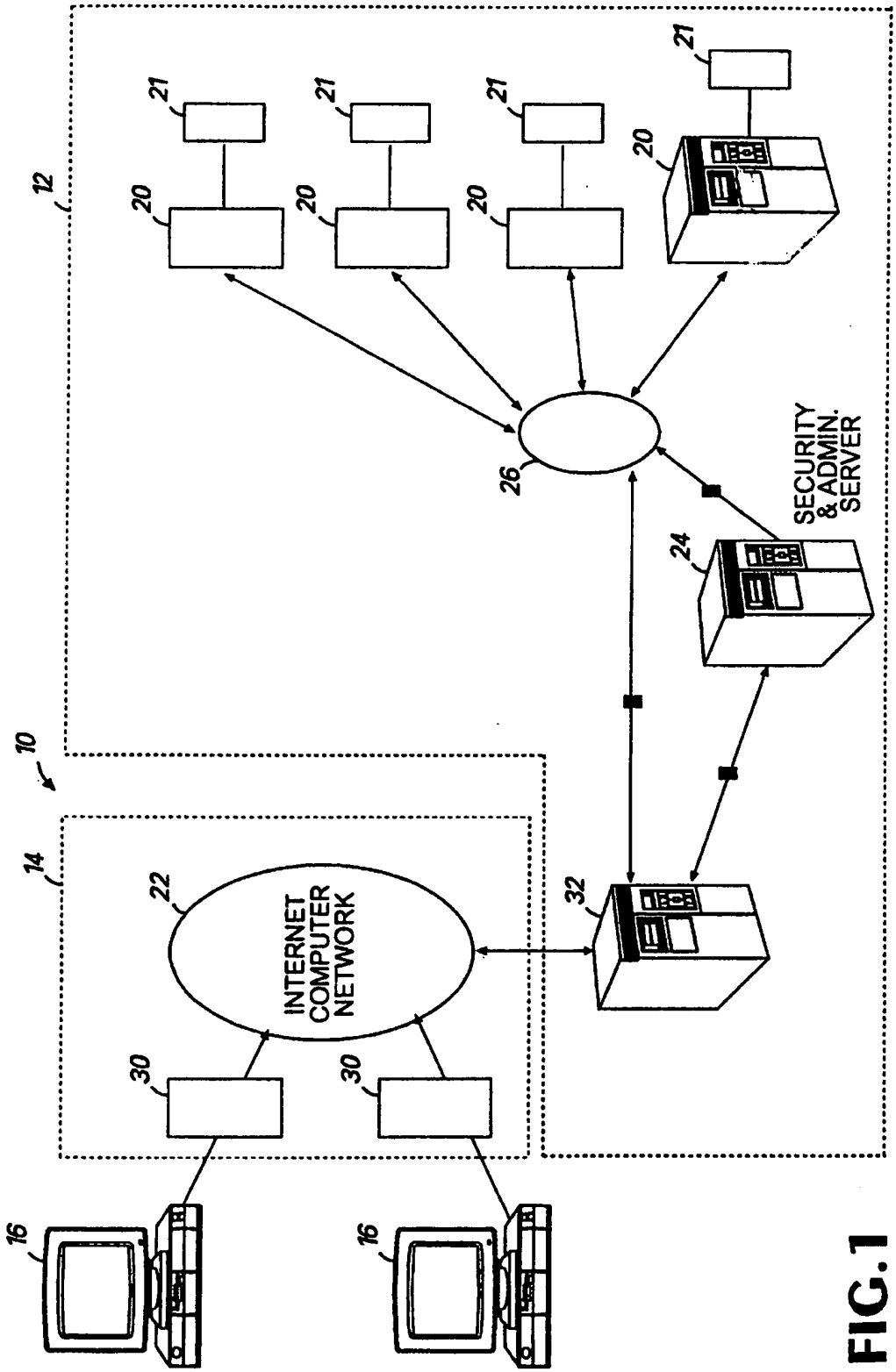

12
21
20
26
SECURITY & ADMIN. SERVER
24
10
14
22
INTERNET COMPUTER NETWORK
32
30
16

FIG.1

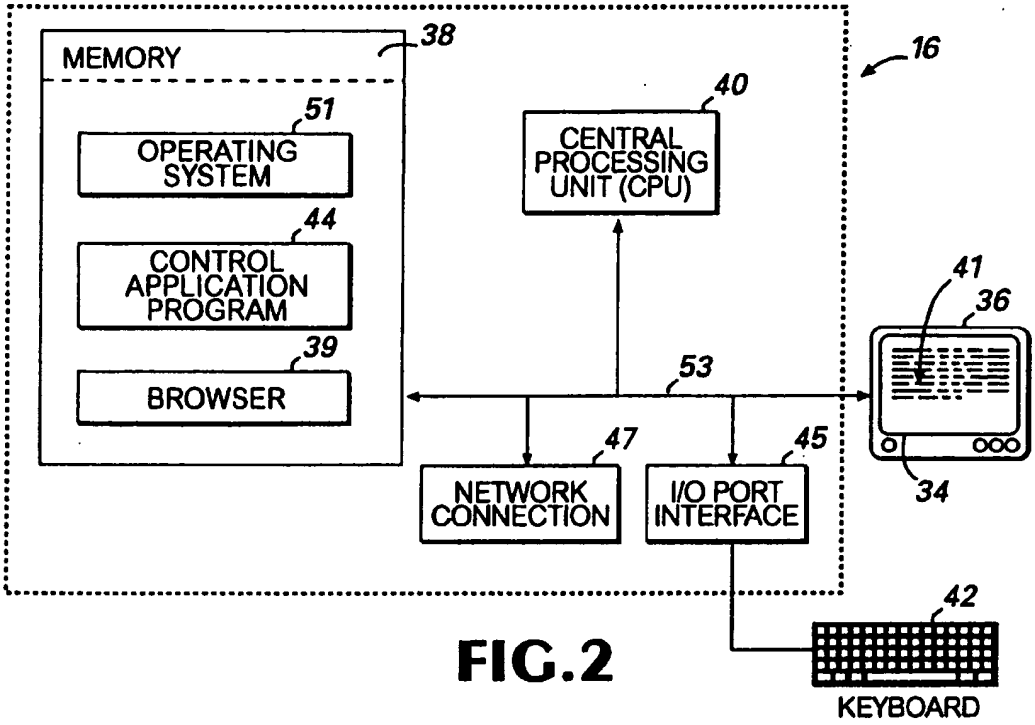

MEMORY
38
16
40
51
OPERATING SYSTEM
CENTRAL PROCESSING UNIT (CPU)
44
CONTROL APPLICATION PROGRAM
41
36
39
BROWSER
53
47
45
NETWORK CONNECTION
I/O PORT INTERFACE
34
42
KEYBOARD

FIG.2

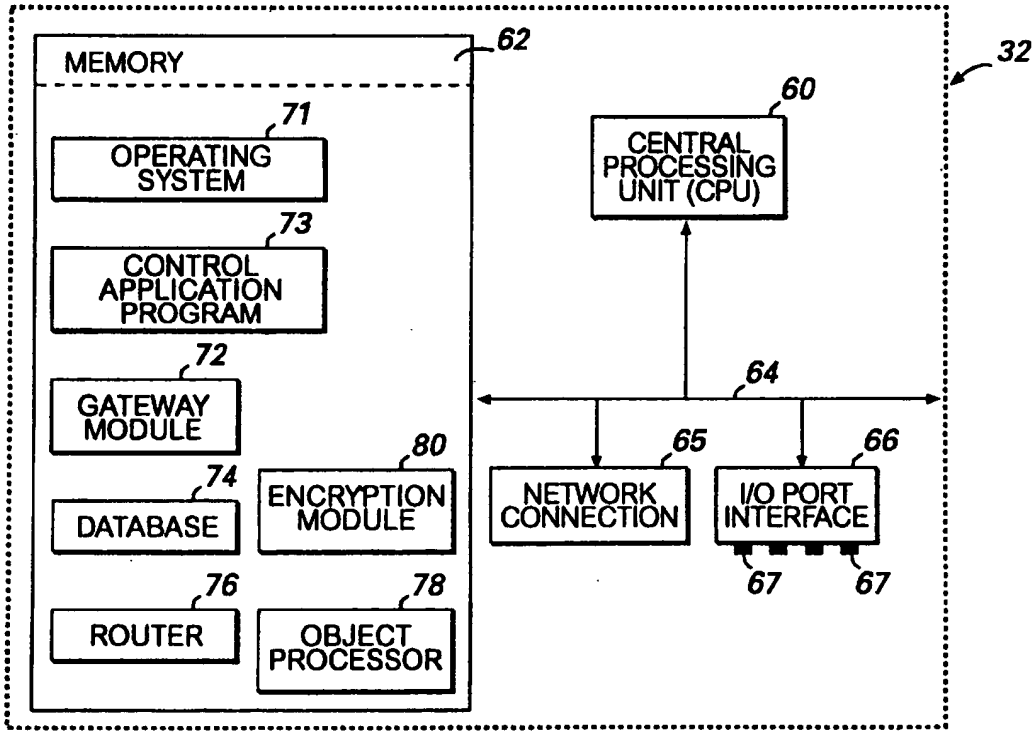

MEMORY
62
32
60
71
OPERATING SYSTEM
CENTRAL PROCESSING UNIT (CPU)
73
CONTROL APPLICATION PROGRAM
72
64
GATEWAY MODULE
80
65
66
74
ENCRYPTION MODULE
NETWORK CONNECTION
I/O PORT INTERFACE
DATABASE
67
67
76
78
ROUTER
OBJECT PROCESSOR

FIG.3

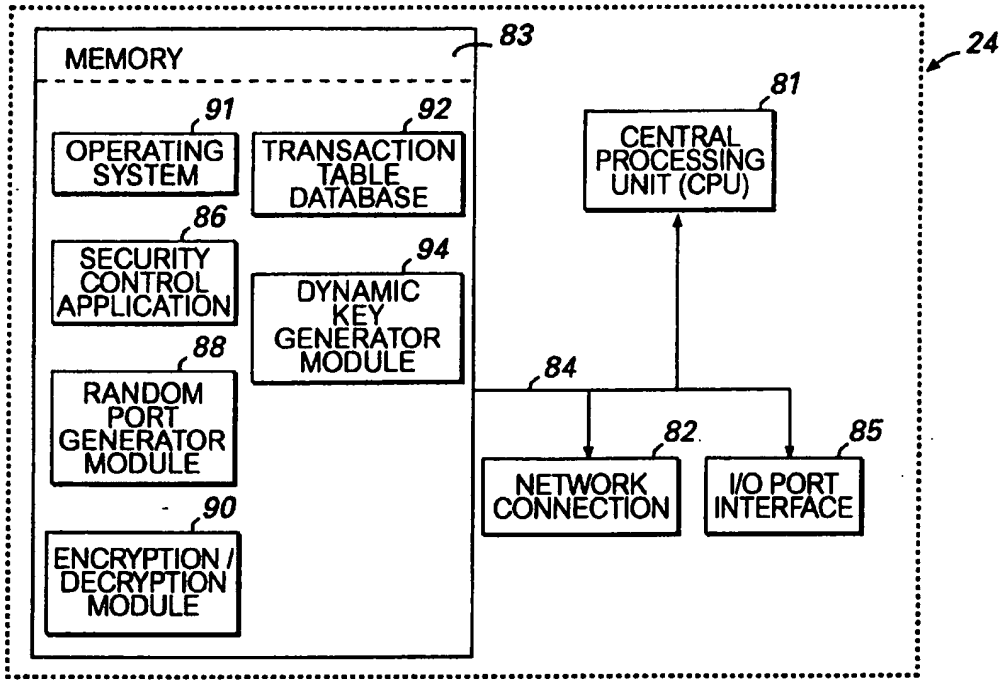

MEMORY
83
24
91
OPERATING SYSTEM
92
TRANSACTION TABLE DATABASE
81
CENTRAL PROCESSING UNIT (CPU)
86
SECURITY CONTROL APPLICATION
94
DYNAMIC KEY GENERATOR MODULE
88
RANDOM PORT GENERATOR MODULE
84
82
85
NETWORK CONNECTION
I/O PORT INTERFACE
90
ENCRYPTION / DECRYPTION MODULE

FIG.4

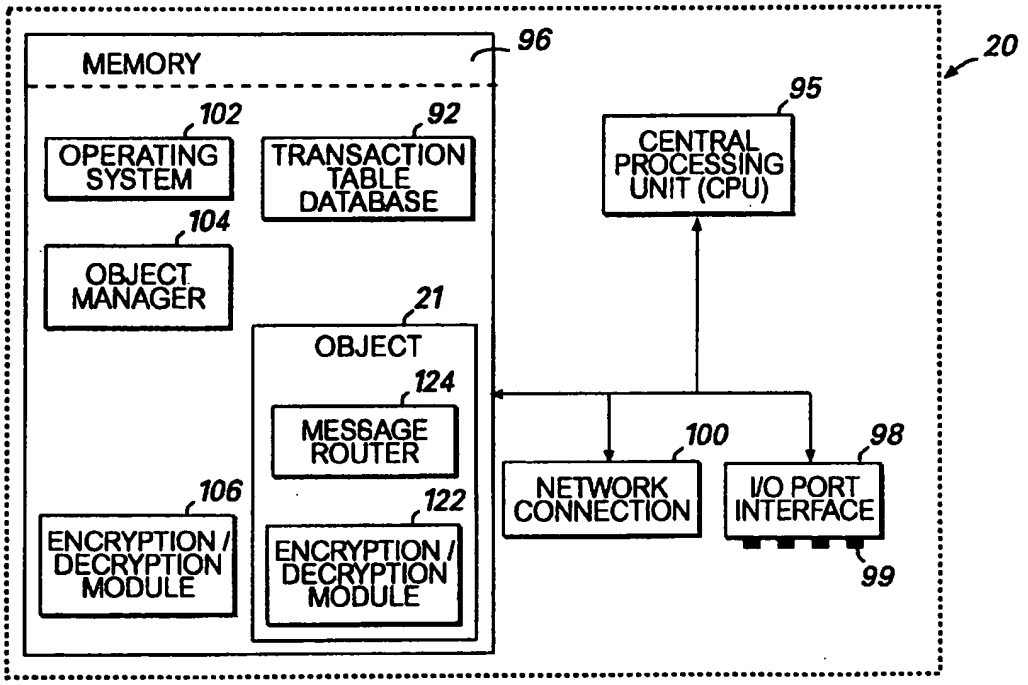

MEMORY
96
20
102
OPERATING SYSTEM
92
TRANSACTION TABLE DATABASE
95
CENTRAL PROCESSING UNIT (CPU)
104
OBJECT MANAGER
21
OBJECT
124
MESSAGE ROUTER
100
98
NETWORK CONNECTION
I/O PORT INTERFACE
106
ENCRYPTION / DECRYPTION MODULE
122
ENCRYPTION / DECRYPTION MODULE
99

FIG.5

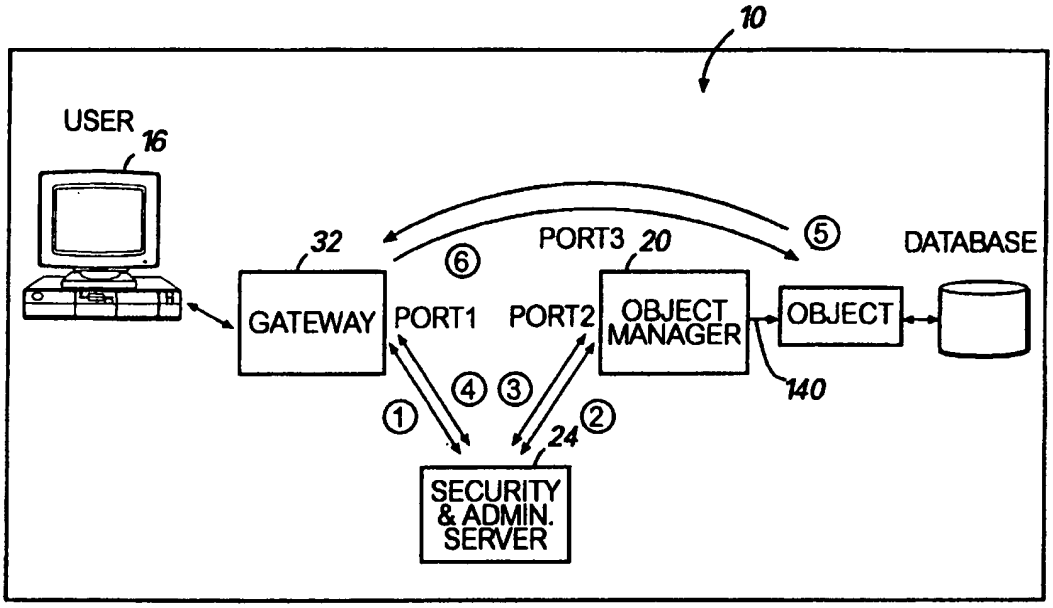

10
USER
16
32
PORT3
20
DATABASE
GATEWAY
PORT1
PORT2
OBJECT MANAGER
OBJECT
140
24
SECURITY & ADMIN. SERVER

FIG.6

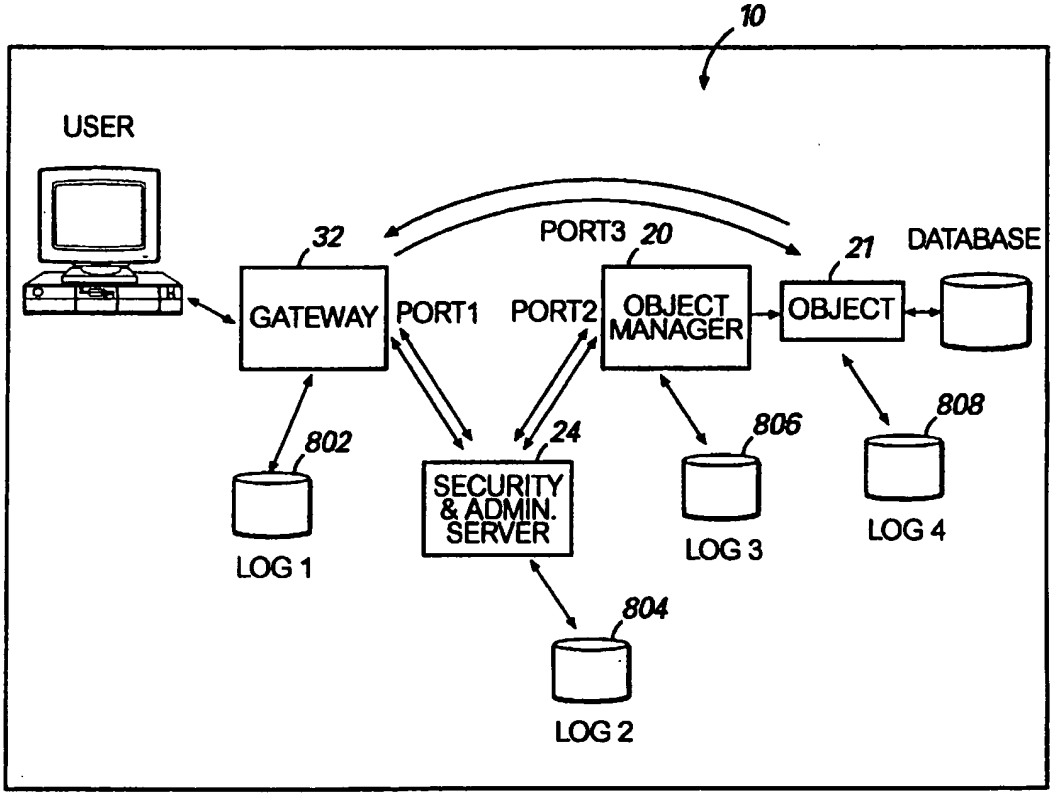

10
USER
32
PORT3
20
21
DATABASE
GATEWAY
PORT1
PORT2
OBJECT MANAGER
OBJECT
802
24
806
808
SECURITY & ADMIN. SERVER
LOG 1
LOG 3
LOG 4
804
LOG 2

FIG.8

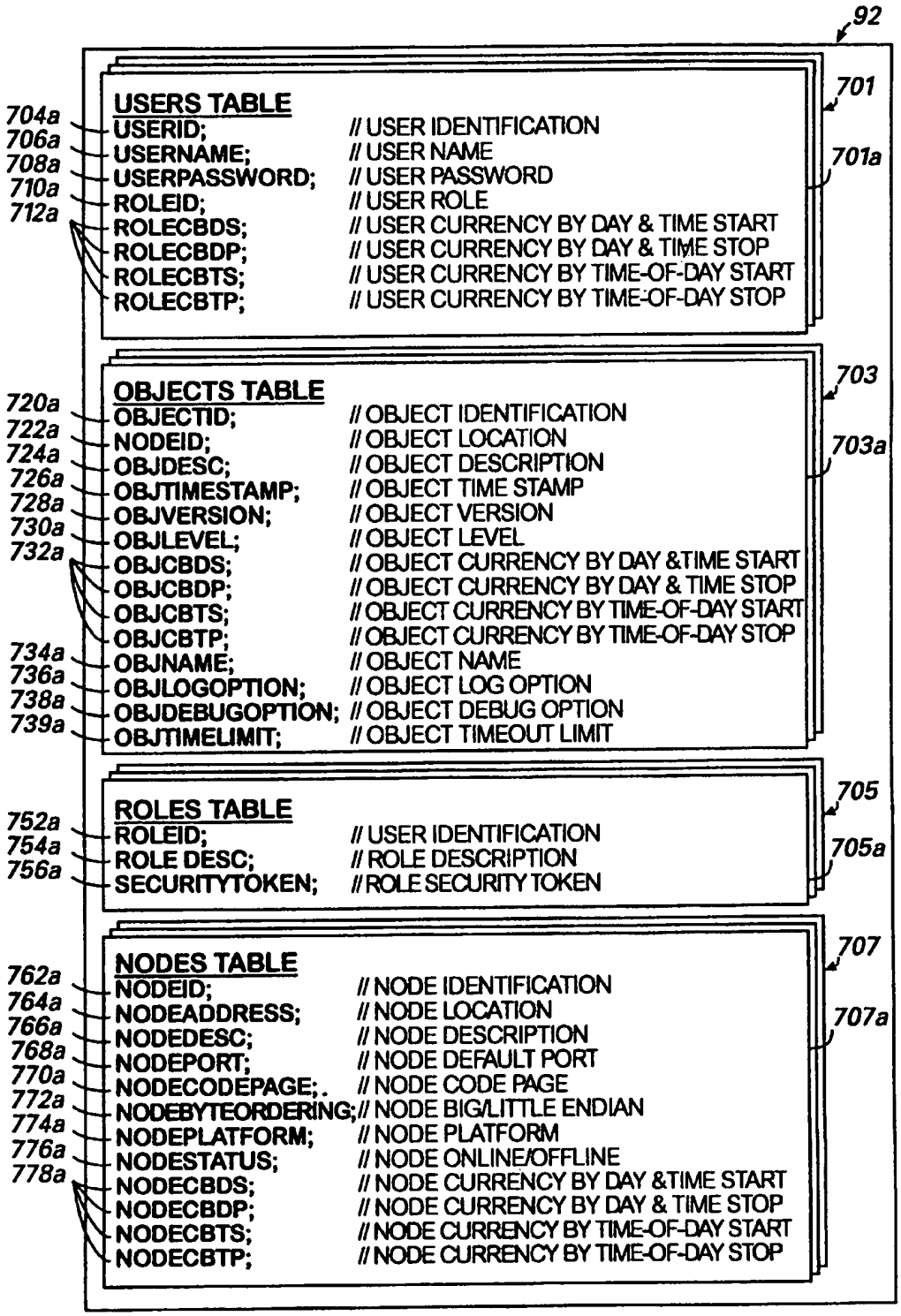

92
701
701a
USERS TABLE
704a USERID; // USER IDENTIFICATION
706a USERNAME; // USER NAME
708a USERPASSWORD; // USER PASSWORD
710a ROLEID; // USER ROLE
712a ROLECBDS; // USER CURRENCY BY DAY & TIME START
ROLECBDP; // USER CURRENCY BY DAY & TIME STOP
ROLECBTS; // USER CURRENCY BY TIME-OF-DAY START
ROLECBTP; // USER CURRENCY BY TIME-OF-DAY STOP
703
703a
OBJECTS TABLE
720a OBJECTID; // OBJECT IDENTIFICATION
722a NODEID; // OBJECT LOCATION
724a OBJDESC; // OBJECT DESCRIPTION
726a OBJTIMESTAMP; // OBJECT TIME STAMP
728a OBJVERSION; // OBJECT VERSION
730a OBJLEVEL; // OBJECT LEVEL
732a OBJCBDS; // OBJECT CURRENCY BY DAY &TIME START
OBJCBDP; // OBJECT CURRENCY BY DAY & TIME STOP
OBJCBTS; // OBJECT CURRENCY BY TIME-OF-DAY START
OBJCBTP; // OBJECT CURRENCY BY TIME-OF-DAY STOP
734a OBJNAME; // OBJECT NAME
736a OBJLOGOPTION; // OBJECT LOG OPTION
738a OBJDEBUGOPTION; // OBJECT DEBUG OPTION
739a OBJTIMELIMIT; // OBJECT TIMEOUT LIMIT
705
705a
ROLES TABLE
752a ROLEID; // USER IDENTIFICATION
754a ROLE DESC; // ROLE DESCRIPTION
756a SECURITYTOKEN; // ROLE SECURITY TOKEN
707
707a
NODES TABLE
762a NODEID; // NODE IDENTIFICATION
764a NODEADDRESS; // NODE LOCATION
766a NODEDESC; // NODE DESCRIPTION
768a NODEPORT; // NODE DEFAULT PORT
770a NODECODEPAGE; // NODE CODE PAGE
772a NODEBYTEORDERING; // NODE BIG/LITTLE ENDIAN
774a NODEPLATFORM; // NODE PLATFORM
776a NODESTATUS; // NODE ONLINE/OFFLINE
778a NODECBDS; // NODE CURRENCY BY DAY &TIME START
NODECBDP; // NODE CURRENCY BY DAY & TIME STOP
NODECBTS; // NODE CURRENCY BY TIME-OF-DAY START
NODECBTP; // NODE CURRENCY BY TIME-OF-DAY STOP

FIG.7

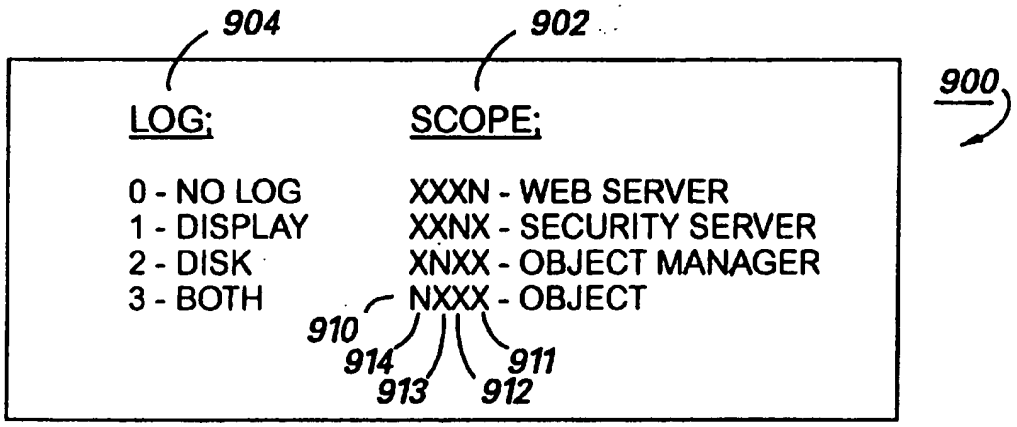

904
902
900
LOG;
SCOPE;
0 - NO LOG
1 - DISPLAY
2 - DISK
3 - BOTH
XXXN - WEB SERVER
XXNX - SECURITY SERVER
XNXX - OBJECT MANAGER
NXXX - OBJECT
910
914
913
912
911

FIG.9

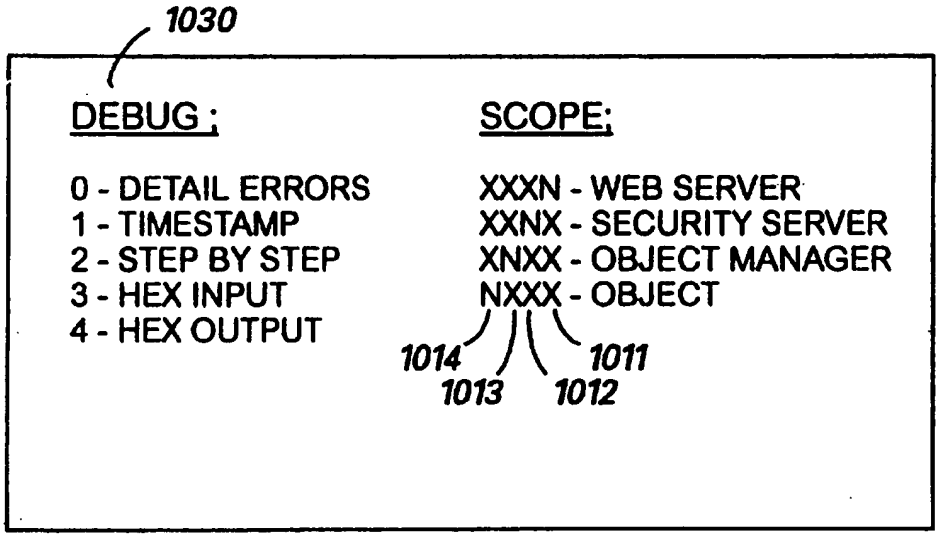

1030
DEBUG ;
SCOPE;
0 - DETAIL ERRORS
1 - TIMESTAMP
2 - STEP BY STEP
3 - HEX INPUT
4 - HEX OUTPUT
XXXN - WEB SERVER
XXNX - SECURITY SERVER
XNXX - OBJECT MANAGER
NXXX - OBJECT
1014
1013
1012
1011

FIG.10

	FIELD	SAMPLE	MESSAGES ①	②	③ ⑤ ⑥	④
1104						
1106	FROMNODE	129. 37. 64. 29	1	1	1	1
1108	FROMTIME	76554345	2	2	2	2
1110	FROMCODEPAGE	ASCII/EDEBIC	3	3	3	3
1112	FROMBYTEORDERING	BIG/LITTLE (1)	4	4	4	4
1114	FROMPLATFORM	UNIX	5	5	5	5
1116	FROMDATAMODE	ASCII/BINARY	6	6	6	6
1118	PASSWORD	UDEMP 1 LL*	7	7	7	7
1120	LOGOPTION	1111	8	8	8	8
1122	DEBUGOPTION	2222	9	9	9	9
1124	USERNAME	CST0	10			
1126	USERPASSWORD	ABC	11			
1128	USERID	21		10		10
1130	SEQUENCENO	15		11		11
1132	OBJECT	123	12	12		12
1134	PUBLICKEY	SDFGEE71		13	10	13
1136	TARGETSOCKET	4567		14		14
1138	TARGETADDRESS	129.37.64.38		15		15
	RETURNCODE	99		16	11	17
1140	GATEWAYDATA	EOD	13	17		
		LENGTH	13	17		
		DATA	13	17		
1142	OBJECT DATA	EOD/EOR		18	12-N	18-N
		LENGTH		18	12-N	18-N
		DATA		18	12-N	18-N
	END	EOM	14	19	13	19

1100

FIG.11

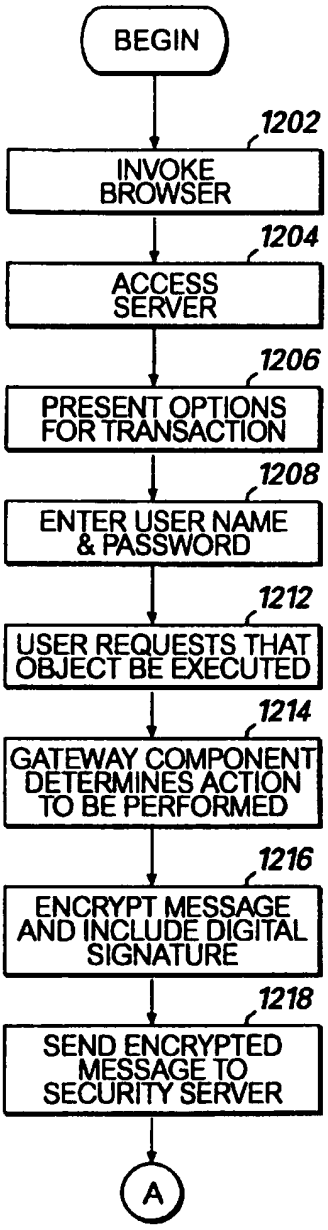


FIG.12A

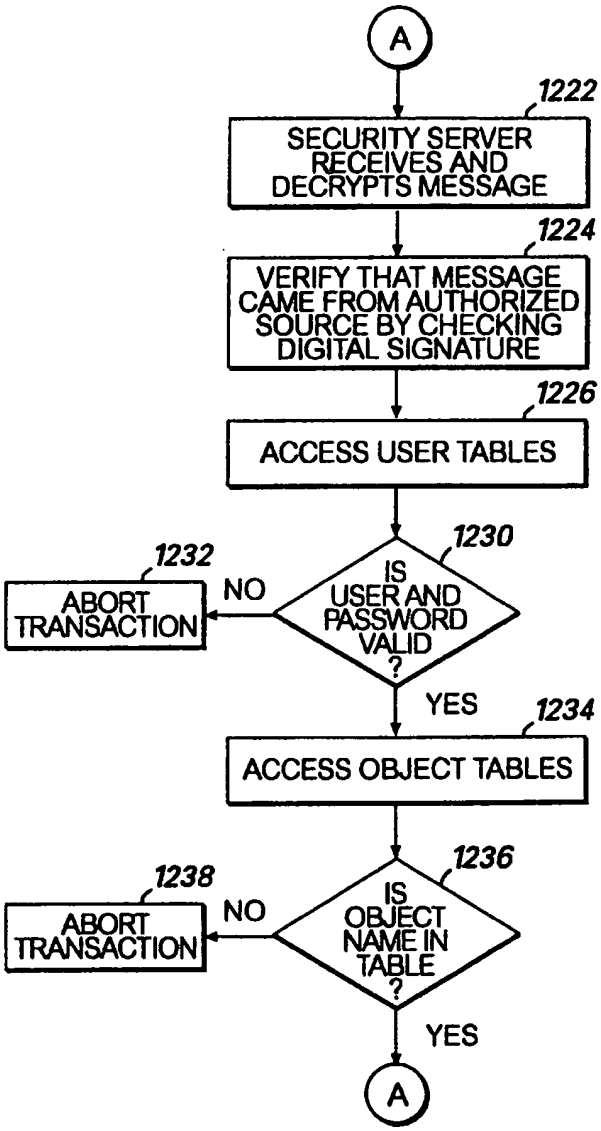


FIG.12B

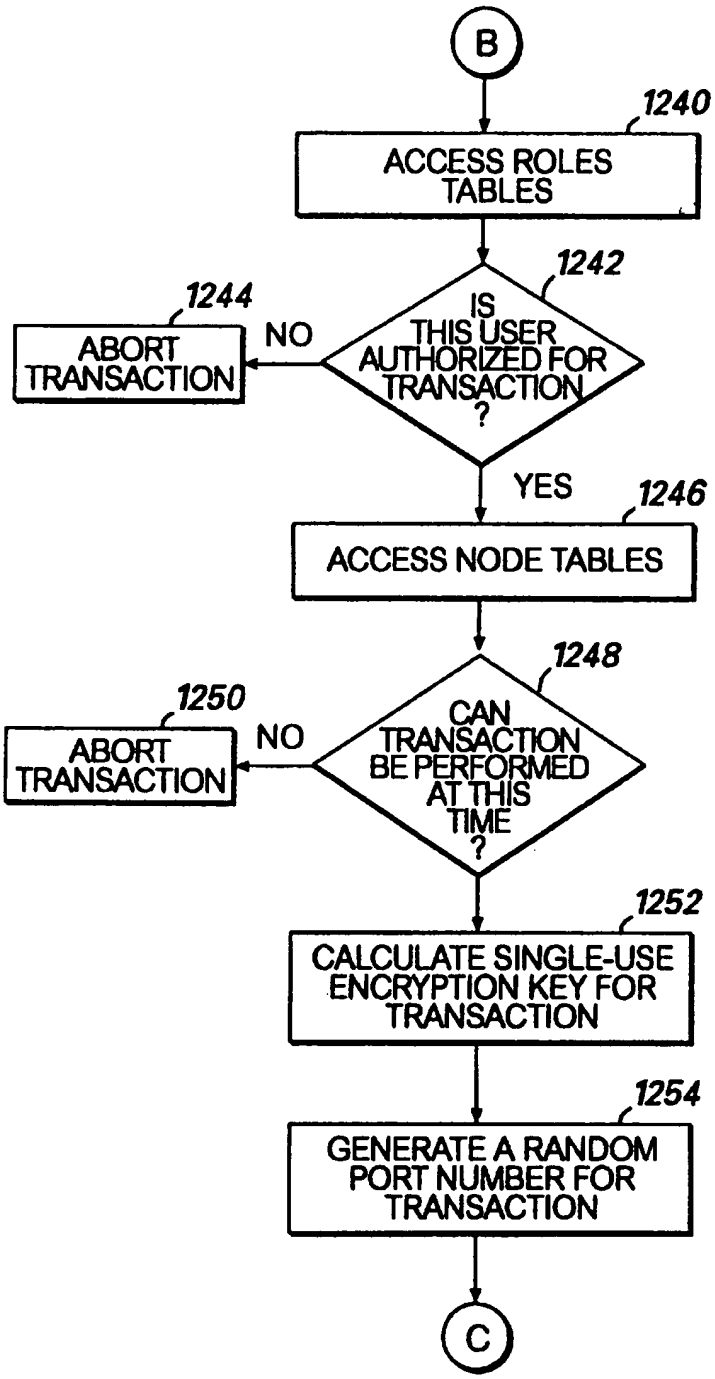

B
1240
ACCESS ROLES TABLES
1242
IS THIS USER AUTHORIZED FOR TRANSACTION ?
NO
1244
ABORT TRANSACTION
YES
1246
ACCESS NODE TABLES
1248
CAN TRANSACTION BE PERFORMED AT THIS TIME ?
NO
1250
ABORT TRANSACTION
1252
CALCULATE SINGLE-USE ENCRYPTION KEY FOR TRANSACTION
1254
GENERATE A RANDOM PORT NUMBER FOR TRANSACTION
C

FIG.12C

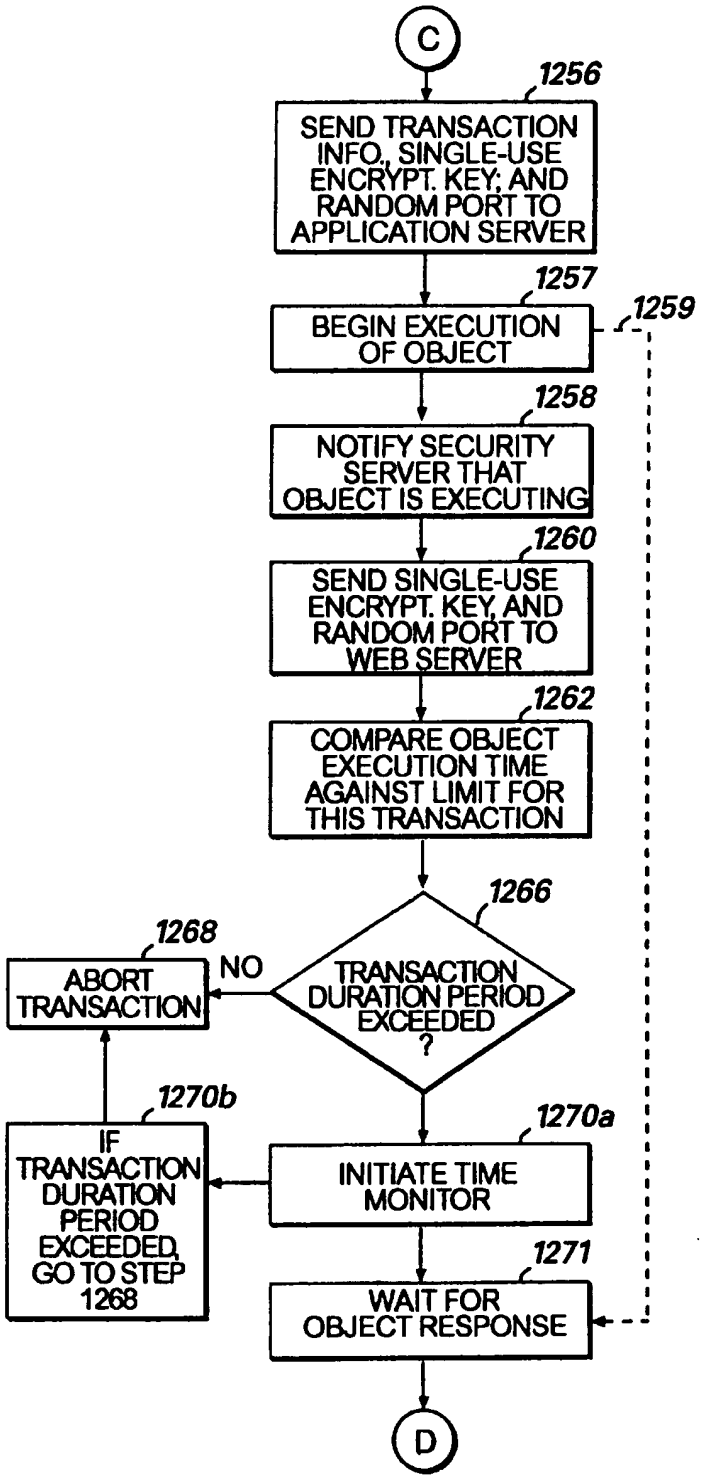


FIG.12D

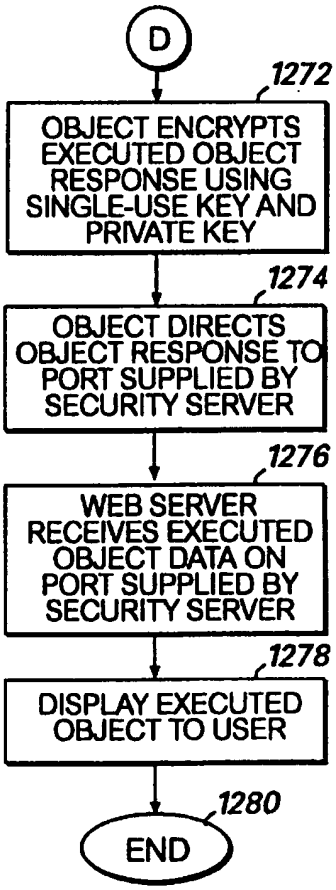


FIG.12E

NETWORK SECURITY AND INTEGRATION METHOD AND SYSTEM

FIELD OF THE INVENTION

The present invention relates to security systems for computer networks and to integrating security systems with an existing network.

BACKGROUND OF THE INVENTION

Computer use and the electronic transfer of information has increased substantially among home and business computer users. The growth in computer use has spurred a demand for creating computer networks to facilitate the transfer and sharing of information. For example, many companies provide computers for most, if not all employees, to facilitate the exchange of information among the employees via a computer network. Many companies have reduced cost associated with computing by adopting client/server networks to aid in the transfer of information between company computer systems. Networks within a business are often referred to as local area networks (LANs). A local area network is a group of computers and other devices disbursed over a relatively limited area and connected by a communications link that enables any device to interact with any other on the network. LANs often include microcomputers, mainframe computers and shared resources such as printers and hard disks. Many LANs can support a wide variety of computers and other devices. The devices connected to the LAN must use the proper physical and data-link protocols for the particular LAN, and all devices that communicate with each other use the same upper-level communications protocol.

By using client/server networks, companies consolidated many of their computer processing applications, databases or needs in a central computer processing center. With a central computer processing center containing most if not all the computer programs and databases of the company, programs that provide scheduling, inventory monitoring, order placement, account processing, or data exchange processing necessary for efficient management of the business may be readily obtained by a distributed group of workers. By providing a centralized operating environment with company records and programs, employees of large companies have access to and know of transactions being carried out or performed by other employees at the office although the employees may be located in different office buildings or different floors of the company. Therefore, several employees can work independently of each other to schedule customer appointments, take orders, process accounts and have the data records of the company updated in a centralized facility so as to avoid duplicative or conflicting actions.

As computer use and network use has increased in companies, so to has computer use and network use increased among individual home users. While these home users do not generally set up a special network to communicate with other home users, the home computer users, as well as businesses, can gain access to a global computer (wide area) network often referred to as the Internet. By gaining access to the Internet, all types of computer users may be connected.

Because many companies are aware of the growth of computer use in most environments, these companies seek to reach these users or potential customers through a computer network, which is most often the Internet computer network. Many companies reach the potential customers by providing one of several different types of methods of

communicating over the network. For example, a business may provide a graphic advertisement over a computer network, an interactive request system to a special database set up for user interaction, or an interactive processing system that enables a customer to interact with a company's internal computer network. Companies usually desire to enable customers to access the internal company network to perform simple important tasks that reduce company overhead, such as processing banking account information or room scheduling for a hotel.

Although providing access to a company network and systems is desirable in many situations, it is not always practical for several reasons. For example, the internal networks of companies often contain confidential data such as inventory data, customers accounts, price structuring information, business leads and plans, and other business critical data. While this type data may not be generally accessed by customers, some customers or users may be skilled in defeating general security measures of computer systems and may access the confidential information. Computer users who attempt to compromise computer security systems are often referred to as computer hackers or crackers. Therefore, security concerns often can make access to a company's network risky or impractical. Additionally, many companies have invested from several thousand to millions of dollars on computer systems that incorporate mainframe/legacy systems. These mainframe/legacy systems are often specially designed for the business to process information quickly and efficiently in the business' environment. However, these legacy systems are not readily adaptable to interact directly with public networks such as the Internet to facilitate customers use. Particularly, the messaging systems of these legacy systems are not adapted to interact efficiently with the Internet public network. Furthermore, because legacy systems are custom designed systems, it can be a difficult task for a manager of the system to continually update the programming of the system to allow customers to access new or updated systems on the network and to account for a changing customer base.

With respect to the security of systems, many companies use a computer protection device, known as a firewall, in association with the company computer server that provides access to the Internet. A firewall is a device located on the Internet that examines the information in a header of a data communication and blocks entry if the header information contains or does not contain certain information. An experienced computer hacker can monitor Internet traffic and obtain the node address of an authorized or trusted user of the company's computer system then fake the address to obtain access to the company's computer system. A firewall does not prevent such deception. Current firewall technology provides limited protection against professional hackers. Additionally, firewalls only provide protection measures for information contained in headers and header information only contains standardized information as promulgated by a standards committee for Internet protocol. Due to the standardized nature of headers, firewalls do not provide flexible security options. Because the firewall is an Internet device, once this Internet security measure is broken the companies records are exposed to the computer hacker.

Thus, there is a need for a security system that enables a private network of computers to be accessible via an open network and that provides a higher level of security than that afforded by firewalls. Additionally, there is a need in the art for a network security system that enables a private computer network that incorporates specialized computer systems to be used in connection with an open network without

substantial modification to the specialized computer systems. Furthermore, there is a need for a network security system that may be easily managed by a network security manager.

SUMMARY OF THE INVENTION

Generally described, the present invention provides a network security system that provides a single point of access control to one or many source computer systems. The present invention provides various mechanisms for securing access to source computer systems that includes generating single-use encryption keys, generating random port assignments for communication between devices, using an asynchronous messaging protocol in the security system and utilizing various levels of transaction tables to help secure and manage security parameters of the system.

More particularly described, the present invention provides a method for securing access to a plurality of computers connected via a network. In this method, an indication is received that a first user of a first computer program module desires to communicate with a source computer system over the network. When this indication is received, a message is directed to a security computer system. The security computer system, functioning as an access control manager to the source computer system, determines whether the first user is authorized to access the source computer system. If the security computer system determines that the first user is authorized to access the source computer system, the security computer system sets up a communication protocol between the first computer program module and the second computer program module.

Additionally, the communication protocol that is set up between the first computer program module and the source computer system may be terminated if a selected time period is exceeded. Also, setting up the communication protocol may include selecting, in response to the step of receiving the electronic communication, one port of the multiple ports of the source computer system to be used for communication of information over the computer network between the first computer program module and source computer system. The first computer program module communicates with the source computer system via the selected one port and the source computer system communicates with the first computer program module via the one port. The one port is preferably selected by a randomizing selection program module. The port may be changed for each transaction by the randomizing routine.

Another method of the security system may include providing encryption keys to a first computer program module and a second computer program module where each program module is stored in a computer system. One step of the method includes receiving a message that is to be encrypted. In another step, a message specific encryption key is generated in response to receipt of the message. The message specific encryption key is transmitted to the first and the second computer program modules. The first and second computer program modules are operative to use the message specific encryption key to encrypt or decrypt a message transmitted between the first and second computer program modules. Message specific encryption keys are preferably single-use encryption keys that are newly generated for each message transaction that is to occur.

Another computer-implemented method of the present invention includes authenticating and granting access privileges to a user of a first computer system who wants to communicate with a source computer program module. An indication is received that a first user of the first computer program module desires to communicate with a source computer system. In response to the indication, digital signatures are used to authenticate that the request was received from a trusted user. Next, a first set of tables is accessed that contains identification information which indicates whether computer users have access privileges to the source computer system, or systems, being managed by the security system. Next, a second set of tables is accessed to determine whether the requested source computer module exists, and is known to the security system. The second set of tables identify the source computer program modules available for access on the second computer system, or systems, being managed by the security system. Next, a third set of tables is accessed that specify whether the first user has access privileges to the indicated source computer program module. The third set of tables identify the source computer modules to which specific users have access. Finally, a fourth set of tables is accessed to determine if the requested system is available (on-line), and to provide addressing information for the source computer. Following these steps, the user is enabled to access the indicated source computer module from the first computer program module if the user is authorized to access the source computer system, if the identified source computer program module is contained in the second set of tables, if the identified source computer program module is contained in the second set of tables, if the third set of tables indicate that the user has access privileges to the indicated source computer program module, and if the source computer is operational (on-line).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is diagram of the network components used in connection with the preferred embodiment of the network security system.

FIG. **2** is a diagram of a customer or user computer system used in connection with the present invention.

FIG. **3** is a diagram of web server computer system used to handle network transaction traffic between a user computer system and application server computer system as used in connection with the preferred embodiment of the network security system.

FIG. **4** is a diagram of a security server used in connection with the present invention that operates to control access to an application server computer system.

FIG. **5** is a diagram of an application server computer system used in connection with the preferred embodiment of the network security system.

FIG. **6** is a diagram that illustrates the messaging protocol utilized in connection with the present invention.

FIG. **7** is a diagram of the transaction tables database used in connection with the present invention.

FIG. **8** is a diagram of points within the network security system in which data may be logged.

FIG. **9** is a diagram of the data format that indicates which network points are to receive logging data.

FIG. **10** is a diagram of the data format that indicates where to log data at the network points.

FIG. **11** is a diagram of a representative message format used in connection with the preferred embodiment of the present invention.

FIGS. **12***a*, **12***b*, **12***c*, **12***d*, and **12***e* are flow diagrams of the processes of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, FIG. **1** illustrates the basic components of a network security system **10** as used in

connection with the preferred embodiment of the present invention. The network security system **10** of the present invention may serve to integrate devices not designed for use with the protocols of a particular network. Particularly, the network security and integration system of the present invention enables a private network **12** of computers associated with a particular entity, such as a bank, to be integrated with an open network **14** while ensuring that transactions over the open network **14** to the private network **12** of computers is secure. The network security system **10** helps to secure transactions on the private network of computers by using a single point of access control to the private network. The single point of access control to the private network is preferably implemented as a network security server. Particularly, the system of the present invention utilizes a network security server to authorize and set-up communication between two computer program communication modules.

The network security server ensures that a user seeking access to a source or destination computer system is an authorized user. The network security server also uses encryption techniques to help ensure the confidentiality of messages being delivered. The network security server operates to set-up and secure the communication channel between the two computer systems using a unique messaging protocol. More specifically, the network security server generates single-use public transaction encryption keys for each transaction that is to be performed by a user or users. The network security server delivers the single-use public key to each of the communicating systems. This key is then used by the two communicating systems for encrypting or decrypting messages delivered between the systems for the particular transaction. By generating a single-use public key for each transaction to take place, the security of the system is much more difficult to be compromised because a hacker could not readily discover a continually changing public encryption key. Even if a single-use key was discovered or guessed for one transaction, the key would be different for the next transaction.

The network security system **10** further enhances security by generating random port assignments on which communications between the two computer systems are to take place. The network security server delivers the randomly generated port assignment to each of the computer systems so that when a communication is to be made between the systems, each of the systems knows the port on which the communication is to take place. By using a port selection randomizing routine, a computer hacker cannot monitor or mimic a single port in which communications are to occur to obtain confidential data or to corrupt data because the port assignments for the data being accessed is changed with each transaction. Randomizing port assignments for each transaction in combination with generating a single-use public key for each transaction, provides a significant level of security beyond conventional network computer systems.

Conventional computer security systems limit access to a particular system by requiring a password, user id, predetermined node addresses and specific protocols. However, in addition to these measures, the network security system described herein is enabled to limit access of an authorized user to specific systems, specific transactions available on the system and specific times in which a user may access the data of the system. Additionally, the network security system provides a security measure that aborts a transaction if the transaction exceeds a certain duration of time. The duration allotted for a particular transaction is based upon the time in which it takes to generally complete the transaction. By limiting the duration of the transaction between a user computer system and the source computer system to the general transaction time, a computer hacker does not have time to stay on the computer system long enough to analyze or significantly alter applications or corrupt data within the source computer system.

Preferably, many of the authorization functions performed in the network security system are performed in conjunction with tables that specify the users and passwords for the user, the different levels of authorization required for access to systems, transactions, or information protected by the network security system **10**. The transaction tables constructed and used according to the present invention enable a security manager of the network security system to easily manage and update access privileges when users change or when computer systems on the network are changed or updated.

The Preferred Operating Environment

Before providing a detailed description of the systems and methods of the present invention, a brief description of the preferred operating environment and the equipment of the operating environment is provided. Referring to FIG. **1**, the network security system **10** includes many components that operate to secure transactions and integrate components of one network to another. The network security system **10** ensures that a computer system **16** is authorized to access application servers **20** over a computer network, such as the computer network **22**. These security processes or measures taken by the network security system **10** are preferably controlled by the security server **24** in response to a computer system **16** attempting to access the application servers **20** over the open computer network **22** or the internal computer network **26**. The open computer network **22** is preferably the computer network commonly referred to by those skilled in the art as the Internet.

The Internet is a network of computers that connects many governmental, university, and private computers together and serves as a means for making a vast quantity of information available to computers connected to the network. Computers, such as computers **16**, that have access to a computer network are generally referred to as being "set up" on the computer network. When a device has a connection to the network, the device communicates over the network using an appropriate network protocol, such as Transport Control Protocol/Internet Protocol (TCP/IP), Hypertext Transfer Protocol (HTTP), and generates graphics via Hypertext Mark-up Language (HTML). In general, a personal computer may be set up on the Internet by subscribing to an Internet service provider or other on-line service company that provides a connection to the Internet for the subscribing computer owner. It should be appreciated that information updates and communications within the communication network used in connection with the present invention may be accomplished by a variety of network protocols or languages known by those skilled in the art.

The computer system **16**, which alternatively may be any appliance operable to communicate over a network, is connected to an Internet server computer **30**. The Internet server computer **30** is connected to the computer network **22** and enables the computer system **16** to communicate via the computer network **22**. When an Internet connection is provided by the Internet service provider responsible for the Internet server computer **30**, the computer system **16** may seek access to an application server **20** that controls access to applications or objects. Each of the application servers **20** has to an object **21** (e.g. application) that contains the

computer programs and data used to process a desired transaction of a user of the computer system **16**.

In the preferred operating environment, the computer system **16** first accesses a web server **32** when the computer system **16** desires to communicate with any of the application servers **20**. The web server **32** generates HTML data packets to the computer system **16** to display the options available for access to the application servers **20**. The web server **32** passes the data messages from the computer system **16** to the security server **24** indicating that the computer system **16** desires to access the application servers **20**. The security server **24** then determines whether the computer system **16** is authorized to access any of the application servers **20** and whether the user is authorized to access particular applications or objects that execute on the application servers **20**.

Devices that are connected to the Internet utilize addresses to access a particular computer or server on the network. The addresses usually have a specific format such as 10.2.0.52. Each device or workstation connected to a network is assigned a unique code. A standard network address is a 32-bit address field which is broken into two parts. The first part contains the network address; the second part contains the host number. A commonly used notation for Internet host addresses is the dotted-decimal, which divides the 32-bit address into four 8-bit fields. The value of each field is specified as a decimal number, and the fields are separated by periods (for example 010.002.000.052 or 10.2.0.52). Communication between two computers also requires use of ports. A port can be thought of as an endpoint for communication between systems. Each system has over 64,000 ports. Thus, a computer system **16** may access the web server **32** using the address, 10.2.0.52, and using specific port numbers (e.g., port 7171).

Referring to FIG. **2**, the general components of a computer system **16** is described. One aspect of the computer system **16** includes a graphical user interface system **41** operating in conjunction with a display screen **34** of the display monitor **36**. The graphical user interface system **41** is preferably implemented in conjunction with the operating system for displaying and managing the window objects of the system. It should be appreciated that the interface used with the present invention operates in connection with a "web browser" **39** as commonly known in the art.

Although the present invention is described in conjunction with a conventional desktop computer, it will be appreciated that the present invention may be utilized in other types of computer systems that use a window based display system. The graphical user interface system **41** is implemented as part of the computer system **16** to receive input data from a conventional keyboard **42**. Cursor keys on the keyboard **42**, a mouse, trackball, or other pointing device may be used to move a cursor on the display monitor **36** for selection of various options.

For simplicity of the drawings, many components of a standard computer system have not been illustrated such as address buffers, memory buffers and other standard control circuits because these elements are well known and illustrated in the prior art and are not necessary for an understanding of the present invention. A computer program used to implement the various processes of the present invention is generally located in the memory unit **38**, and the processes of the present invention are carried out through the use of a central processing unit (CPU) **40**. Those skilled in the art will appreciate that the memory unit **38** is representative of both read-only memory and random access memory. The CPU **40** is typically implemented as a single-chip microprocessor. The CPU **40**, in combination with computer software, such as an operating system **51**, an application program **44** (optional), and browser **39** controls the operations of the computer system **16**. The operating system software **51**, in conjunction with the browser **39** and application program **44** (optional), controls the allocation and usage of hardware and software resources such as memory, CPU time, disk space, and peripheral devices. The bus **53** of the computer system supports communications of control, address, and data signals between the CPU **40** and the remaining components of the computer system **16**. The memory unit **38** and the CPU **40** are connected by the bus **53** which is designed to provide an electrical interface between computer system components. The processes implemented by the CPU **40** may be communicated as electrical signals along the bus **53** to an input/output device via input output interface **45**. A network connection **47** is provided to connect to a computer network. The network connection may be a modem, LAN connection or other suitable network connection mechanisms. Other computer systems used in connection with the present invention operate in a similar manner but have program modules that vary depending on the function of the component computer system.

Referring to FIG. **3**, a description of the web server **32** is described in more detail. The web server **32** includes a central processing unit **60**, a memory unit **62**, a computer system bus **64**, network connection **65**, and an I\O port interface **66**. The I/O port interface **66** contains a plurality of ports **67** that are used to communicate with external devices, such as an object **21**. In a typical implementation, the web server contains over 64,000 ports. The memory unit **62** of the web server **32** contains several program modules including, an operating system **71**, a gateway program module **72**, a control application **73**, and a web server database **74**. The gateway program module **72** transfers information received from a computer system **16** and converts the information to a form compatible with the data formats used in the security server **24**. The gateway program module **72** returns information to the web server in a format defined by the Common Gateway Interface (CGI) specification. The web server returns this information to a user to indicate to the user, the objects, or applications available to the user at the site accessed by the user. The web server **32** includes a router **76**, an object processor **78** and an encryption module **80**. The router **76** routes requests for services from user applications of the computer system **16** to the security server **24**. As generally discussed above, after the security server **24** authorizes the desired transaction, the gateway program module **72** communicates directly with application servers **20** in order to complete a desired transaction. During the communication with the application server **20**, the object processor **78** receives outputs from objects **21**. The encryption module **80** encodes and decodes messages transmitted in accordance with the present invention. The encryption module **80** encrypts messages when the web server **32** receives a request from a user of computer system **16**. The encryption module **80** encrypts the messages being transferred from the web server **32** to the security server **24** and the application server **20**. The encryption module **80** decrypts messages received from the application server.

Referring to FIG. **4**, a description of the security server **24** is described in detail. The security server **24** includes a central processing unit **81**, a network connection **82**, a memory unit **83**, a computer system bus **84**, and an I\O port

interface **85**. The security server **24** communicates with external computer systems or devices via the I\O port **85**. The security server **24** provides a single point of control for performing the security and administration services of the network security system **10**. The memory unit **83** contains a security control application module **86**, a random port generator module **88**, an encryption module **90**, operating system **91**, transaction tables **92**, and a dynamic key generator module **94**. The security control application module **86** manages the coordination of the processes of the various modules implemented at the security server **24**. The encryption module **90** decrypts messages delivered to it from the web server **32** and the application server **20** and encrypts messages delivered to the web server **32** and the application server **20**. The transaction tables **92** are accessed for each transaction desired by a user. The transaction tables **92** are accessed to determine whether the transaction exists, whether the system on which the transaction resides is active, and whether the user has authority to implement or use the transaction desired by the user. If the user is an authorized user for the transaction, the random port generator module **82** and the dynamic key generator module **94** are activated to generate a random port number and single-use public key, respectively. As known to those skilled in the art, a TCP/IP computer has more than 64,000 ports. The random port generator module **88** randomly selects an unused port for which a communication between an application server **20**, within a range defined by the system administrator, and a user computer system **16** is to communicate for this particular transaction. Additionally, the dynamic key generator module **94** generates a random public key to be used by the application server **20** and the web server **32** during communications between the two systems. The transaction specific port and the single-use public key are transmitted in an encrypted message to both the application server **20** and the web server **32**, as discussed in more detail below.

Referring to FIG. **5**, the application server **20** used in connection with the present invention is shown in detail. The application server **20** contains a CPU **95**, memory unit **96**, a computer system bus **97**, an I\O port interface **98**, and a network connection **100**. The I/O port interface **98** includes a plurality of ports **99** that are used to communicate with external devices, such as the web server **32**. The memory unit **96** contains various application modules used in connection with the application server **20**. The memory unit **96** contains an operating system **102**, an object manager program module **104**, an encryption program module **106**, and objects **21** (one object illustrated). The object manager program module **104** selects and initiates execution of objects **21** of the computer system. The encryption program module **106** encrypts and decrypts messages transmitted to and from the security server **24** in connection with the present invention. The object typically resides on the application server **20**. Each object **21** consists of a message router **124**, an encryption/decryption module **122**, and object application code. The object manager **104** initiates execution of the object application code. The object **21** executes and performs the desired transaction by a user of the computer system **16**. The application module is executable code preferably developed by the user organization. It usually is written in the C programming language. The encryption/decryption module **122** encrypts data processed by the object **21** before the message is routed back to the appropriate web server **32** by the message router **124**. The message router **124** outputs information via an I/O port that was randomly selected by the security server **24**.

Message Protocol

As discussed above, an advantageous aspect of the network security system **10** is the single point of access control between user computer systems **16** and application servers **20**, as well as the messaging protocol used in communication between devices of the network security system **10**. Referring to FIG. **6**, a messaging protocol as occurring between a single computer system user **16** and an application server **20**, is discussed to illustrate the protocol and operations performed in conjunction with the processes of the present invention. When a user of computer system **16** accesses the web server **32**, the user may select a desired transaction that is displayed in response to the users access of the web server. When the user selects an object or transaction to be executed, message **1** (messages are represented by encircled numbers) is sent from the web server **32** to the security server **24**. The gateway component of the web server **32** is executing a CGI gateway which means that the request was initiated from a web browser or from a JAVA applet. It should be appreciated by those skilled in the art that a computer system user may interface directly with a gateway module that is not part of a web server. The message **1** is encrypted and has located therein a digital signature that is used to authenticate the source of a message and to help ensure data integrity. Digital signatures, or cryptographic checksums, are hashing techniques commonly known to those skilled in the art. When the gateway program module receives the request for a transaction on an application server **20**, the only information available at the gateway module is the node address and port that is to be used to address the security server **24**.

Several functions are performed by the security server **24** upon receipt of the message **1**. The security server **24** first decrypts message **1** then authenticates that message **1** was received from an authorized gateway program module. A digital signature is calculated as known by those skilled in the art and compared to the digital signature in the decrypted message **1**. If the encryption program module determines that the digital signatures are equal, gateway authentication is satisfied. After determining that the gateway program module is authorized, the security server **24** determines whether a user is authorized. The security server **24** accesses four transaction tables to determine whether the user of computer system **16** is authorized to access the object identified in the user's request. The tables that are used to verify whether a user is authorized to perform a certain transaction are the user table, object table, node table, and roles table. These tables are searched to determine if a user can access a particular object during a certain time and whether time constraints are imposed on certain nodes. The nodes table provides the node address of the computer system on which the transaction is to be executed.

If the user is authorized to perform the desired task given the constraints defined in the transaction tables, the dynamic key generator module **94** generates a single-use public key to be used for encrypting and decrypting data transmitted between the object and the gateway components of the web server **32**. Additionally, the random port generator module **88** implements a randomizing routine to generate a random port number that is to be used for the transmission of information between the object and the gateway component of the web server **32**. Generally, a range of acceptable addresses is defined by the system administrator from which the random port number is selected. The security server **24** also assigns a transaction time-out value for the transaction as determined from the object table. After the security server **24** performs each of these functions, the security server **24** sends a message to the object manager **104** of the application server **20**.

Message 2 contains information that authorizes the object manager 104 of the application server 20 to perform specific tasks and provides the encryption keys and port addresses to be used for the transmission of data between the object and the gateway components of the web server 32. Additionally, the object manager evaluates the time-out values for the transaction. The application server 20 initiates execution of the requested object and passes certain information to the object as indicated at 140. The information is transmitted to the object using either temporary files, shared memory or message queues. A run-time component of the message protocol is linked with user-written object code. These run time components are the message router 124 and encryption program schedule 124. This run-component uses information from the object manager 24 to control execution of the object and to return output to the gateway program module of the web server 32.

If the time-out value for the transaction is exceeded, the object execution for this transaction is aborted and this event may be logged. As discussed above, by limiting the time of a transaction over the network to a predetermined execution time, the time in which a computer program hacker has to tamper with or corrupt an application or data is very limited. Therefore, the time limit for execution of a transaction provides a further security measure in addition to the single-use public keys and random port selection method.

When the object manager of the application server 20 initiates execution of the object, the object manager sends message 3, asynchronously, back to the security server 24 to confirm to the security server 24 that the object is executing. When the security server 24 receives the message 3, the security server 24 sends message 4 to the gateway program module of the web server 24. Embedded in the encrypted message 4 is the single-use public key generated by the dynamic key program module 94 that is to be used for decrypting data transferred between the gateway program module and the object. The single-use public key is the same key transmitted to the object manager of the application server in message 2. This single-use public key is unique to this particular transaction. For subsequent transactions, another single-use public key is generated for the then occurring transaction.

The message 4 also contains the port number and time-out value assigned to it for the transaction. Sending messages 3 and 4 asynchronously, with the execution of the object, provides enhanced performance characteristics as compared to previously known systems that are implemented over an open network. Conventionally, in open network systems such as the computer network 22, only one step of a multi-step messaging protocol is performed at a time before preceding to the next step. However, the network security system 10 of the present invention enables the transmission of messages 3 & 4 asynchronous with the execution of the object, therefore providing enhanced performance characteristics. Improvements in performance due to use of the asynchronous method of the present invention over a synchronous method can range in time improvements from several milliseconds to several seconds per transaction depending on system and network loads and characteristics.

When the gateway component of the web server 32 receives the message 4, the gateway component prepares the program modules to receive data from the object using information provided in message 4. This information in message 4 is the port number, single-use public key and time-out values. When the object finishes executing the desired transaction, the object transmits message 5 directly to the gateway components of the web server 32. Thus, the security server module is out of the messaging loop at this point of the transaction. When the web server 24 receives a message 5, the web server delivers message 6 back to the object 21 as a confirmation message that the data sent by the object has been received. In the system of the present invention, data sent by the object is blocked to reduce traffic on the network and to improve performance. For example, multiple short records would be combined, or blocked, into a single message to reduce the number of messages on the network. The gateway program then returns the information to the user program either through an application program interface (API) or by a common gateway interface (CGI) program specification.

Transaction tables

Referring to FIG. 7, the transaction table database is described in detail. The transaction table database 92 contains the tables that are accessed or used by the security server 24 when determining whether a user is authorized for the transaction that the user seeks at the current time. The transaction table database 92 contains four different types of tables: users tables 701, objects tables 703, roles tables 705, and nodes tables 707. A user's table 701*a* is representative of the information contained in the individual user's tables and the transaction table database 92. The user table specifies users that have access to one or more application servers 20 which is verified by a user name and password. The user table 701*a* contains a user identification (ID) field 704*a* that functions as a key for this table, and contains a user name field 706*a* that specifies a user's name and has a user password field 708*a* that specifies the password of the user. If a user enters correct data that satisfies these fields or requirements of one of the tables, the role ID 710*a* is evaluated. The start and stop times for the role are specified in fields 712*a*. If a user inputs the correct user name and password contained within the user tables 701, and the request satisfies the time constraints imposed in the users table 701, the security server 24 searches the object's table to determine whether the object which the user desires to access is in one of the object's tables. An object table 703*a* is representative of the information contained in the object table. The object table 703*a* contains an object ID field 720*a*, a node ID field 722*a*, an object description field 724*a*, an object time stamp field 726*a*, an object version field 728*a*, an object level field 730*a*, an object currency field 732*a*, and an object name field 734*a*, an object option field 736*a*, and an object time limit field 739*a*. The object node ID field 722*a* specifies the node at which the object resides, the object time stamp field 726*a* specifies the time at which the object was added to the objects table, and the object version field 728*a* describes the version of the object of the table. The object currency field 732*a* specifies the times at which an object can be accessed. The object name field 734*a* specifies the name of the object. The object log option field 736*a* enables logging of messages associated with a specific object and the object debug option enables a choice of what level of detail to be included in the log for security and debug purposes. The object time-out limit specifies the duration that the object may be accessed by the user during any given transaction.

If the object exists in the objects table 703 and the time constraints imposed on the object is satisfied, a search is made in the role tables 705 associated with the user to verify that the user is authorized to access the object. The role table 705*a* contains a role ID field 752*a*. The role ID field 710*a* in the users table is matched with the role ID field 752*a* in the role table to determine the role associated with the user. The role table 705*a* has a role description field 754*a*, and a

security token field **756**. The role description field describes the role. For example, the role description field may contain "Read Account Balance." The security token contains an authorization switch for each object authorized for access by the role ID **752***a*.

If all of the authorization conditions specified in the user table, object table, and role tables are passed, the node tables **707** are accessed. For example, the nodes table **707***a* contains a node ID field **762***a*, a node address field **764***a*, a node description field **766***a*, a node port field **768***a*, a node code page field **770***a*, a node byte ordering field **772***a*, a node platform field **724***a*, a node status field **776***a*, and node currency fields **778***a*. The node ID field **762***a* contains the node ID for the specific table. The node address specifies the address of the node identified by the node ID. The node description field describes the node that is to be accessed and the node port field specifies the default port for the node. The node code page field is used to specify the country code page. Code pages are used to define the international languages and special characters that are known to the computer systems. The node byte ordering field specifies the type of translation might be required to map data between computer systems. Some computers record data internally in a format called ASCII, others record information in EBCDIC. The node platform field specifies the platform on which the node resides and the node status field specifies whether the node is on-line or off-line. The node currency field **778***a* specifies the times at which the particular node may be accessed.

While these transaction tables provide an efficient method for specifying the various operations that a user may perform in a relational manner, the use of the tables as identified above also provides for ease of administration. For example, in large computing environments such as institutional banking environments that are making computer systems available to their customers over the network, a system administrator must update users that are authorized to use the system because the bank acquires new customers each day and also loses customers. Thus, the system administrator must account for these users by updating the records of the bank. Additionally, companies frequently replace existing systems with newer systems and consequently the newer systems or updated systems must be modified or made accessible to the users of the computer system. In prior systems, a system administrator often would have to reprogram or code the new system to be operable with the existing customers and clients on a network. However, utilizing the transaction tables of the present invention, a security administrator may simply access and revise information in the node table and/or objects table to ensure that the new system will operate in conjunction with users that are authorized to use a specific function that was replaced or updated. Thus, the transaction tables as described herein provides a system that is easily manageable.

Message Mapping Between Web Server and Legacy Systems

The network security system **10** is particularly adapted to enable existing computer systems of a company to be integrated in an open network such as the Internet computer network **22** (FIG. **1**). The system provides an interface between client programs executing on computers coupled to an open network and computer applications on legacy mainframes/large processing systems. Often these systems are controlled by a UNIX operating system. The client program may be a web browser or other program for communicating messages over an open network in a variety of open network protocols such as HTTP, FTP, e-mail and Telnet. The interface includes a Web server which supports communication in an open network protocol between the Web server and the client program. A gateway module at the Web server converts messages from the client programs to a proprietary data message format. The proprietary data message format is robust enough to support different types of legacy objects such as applications, databases, and other utilities. The object manager maps the message in the proprietary protocol message to an application command or database query which is sent to the legacy object. The response of the legacy object is mapped by the object manager to the proprietary format which may be encrypted by the security module and transmitted to the gateway module. The gateway module converts the response in the proprietary format to the open network protocol for transmission back to a user.

This system provides an interface between users and a legacy system. Because browsers use graphic user interfaces ("GUI"), the users are able to take advantage of the input/output structure of a browser GUI without modification of a legacy object. The system also provides the advantage of using a single message format to support communication between the Web server, security module, and object managers. Such a system extends the useful life of application programs and databases on legacy mainframe systems.

Specifically, the system of the present invention maps from American National Standard Code for Information Interchange (ASCII) to extended binary-coded decimal interchange code (EBCDIC) and vice versa; big Endian byte ordering to little Endian byte ordering and vice versa; and CGI to legacy and legacy to HTTP. The network security system translates information between ASCII and the EBCDIC. This translation is used, for example, if the gateway is executing on an ASCII machine and the object is executing on an EBCDIC machine.

The system of the present invention translates binary control information from big Endian byte ordering (also known as network byte ordering) to little Endian byte ordering (for example, the Intel format). This translation is used, for example, if the gateway is executing on a Motorola or RISC microprocessor and the object is executing on an Intel machine.

If the gateway interfaces to a Web server, the information that the browser passes to the gateway is passed in a specific format as defined by the common gateway interface specification (CGI). Information in the CGI format is translated and transformed into a format that is accessible, useful, and easily manipulated by the legacy application. Also, information returned by the legacy application to the Web server, must be in the HTTP format. Therefore, the system of the present invention maps information received from the Web server to a CGI proprietary format for transmission purposes. The object manager executing on an application server maps the information to a programming interface (GETENV) that is commonly supported on well-known legacy operating systems and defined in ANSI, SAA, POSIX and XPG4 programming specifications. Programming to the HTTP format is accomplished using another programming interface (SPRINTF) which is defined in the ANSI, SAA, POSIX and XPG4 programming specifications. The system of the present invention returns the information to the gateway handling the ASCII to EBCDIC and big to little Endian conversions and blocking and deblocking of data, but does not modify the HTTP format. As indicated in the node byte ordering field **722***a* of the nodes table **707** (FIG. **7**) the messaging format may be specified in the node table.

Transaction Logs

Referring to FIG. **8**, the four points of logging control supported by the network security system **10** as illustrated. Logging information refers to tracking certain information related to the processing of the information or transactions on the network. By logging information at particular points, an administrator operating or monitoring certain aspects of the network security system **10** may determine or observe relevant historical information with regard to the processing of messages and transactions on the network. The network security system **10** provides four points at which information may be logged. The four points at which information may be logged is at the web server **32** indicated by log data **802**; the security server **24** indicated by log data **804**; at the application server **20** as indicated by log data **806**; and at the object **21** as indicated by log data **808**. Referring again to FIG. **7**, the object table **705** has an object log option field **734***a* in which a value may be inserted that specifies where data is to be logged on any of the particular systems. For example, the value inserted in this field may specify that the data is to be logged at the web server **32**, security server **24**, application server **20**, or object **21** and further specifies where to log the data at those systems.

Referring to FIG. **9**, a table is provided that indicates how the log data is encoded for use with the system of the present invention. The log table **900** has two columns: a "scope" column **902** that specifies the location at which the data should be logged in the system and a log column **904** that specifies where at the location the data is to be logged. The location at which data is to be logged may be indicated by one of four values in a location sequence field **910**. The location sequence field **910** has four locations, location **911**, location **912**, location **913**, and location **914**. Each of the locations **911**, **912**, **913**, and **914** correspond to one of the specific points within the network security system **10** in which information may be logged. The values specified in the location sequence field **910** determines where to log the information at the particular system. Referring to column **902**, the device at which data should be logged at a particular point within the system is indicated. For example, a "**0**" in any of the log locations **911**, **912**, **913**, or **914** indicates that no log is to be provided for the corresponding system. A value of "**1**" in a log location indicates that the logging information should be logged to the display of the particular system. A value of "**2**" in any of the locations indicates that the information should be logged to disks at the location indicated by the position variable. A value of "**3**" indicated at any of the position variables indicates that the information should be logged to both the display and to the disk. With respect to the position variables, a value in location **911** indicates that the information should be logged at the gateway according to the logging variable; a value in location variable **912** indicates that the information should be logged at the security server **24** according to the logging variable; a value at location variable **913** indicates that the information should be logged at the application server **20** according to the logging variable; and a value in the location variable **914** indicates that the information should be logged at the object according to the position variable specified.

For example, a log option defined as "**2222**" indicates that the user desires to log information only to disk at the web server **32**, the security server **24**, the application manager **20**, and the object **21**. A log option of "**3011**" indicates that information at the object level is to be logged to both the disk and the display; information at the application server level should not be logged; and that information at the web server **32** and the security server **24** should be logged only to the display.

Referring to FIG. **10**, the table **1000** indicates what information should be logged at the locations indicated by the information of table **9**. Referring also to table **7**, the object table **905** has a field labeled "object debug option **736***a*" which specifies what should be logged. The position variables **1011**, **1012**, **1013**, and **1014** correspond to the web server **32**, security server **24**, application server **20**, and object, respectively, as discussed in connection with FIG. **9**. Table **1000** also has debug values **1030** which specify what should be logged at the particular position specified by the position variables **1002**. A value of "**0**" indicates that detail errors are not to be logged. A value of "**1**" indicates that a time stamp, or time at which the message passed through the system should be included. A value of "**2**" indicates that data is to be logged at a step by step level (i.e., at selected checkpoints within the web server **32**, security server **24**, application server **20** and object). A value of "**3**" indicates that all input messages should be logged in hex format. A value of "**4**" indicates that all output messages should be logged in hex format.

For example, a debug option of "**2222**" specified in the object table **705** at the debug option field **736***a* having a value of "**2222**" specifies a certain logging level. Specifically, the value of "**2222**" in the debug option field **736***a* (FIG. **7**) indicates that logging should occur at a step by step level at the web server **32**, security server **24**, the application server **20**, and the object **21**. A value of "**0314**" in the debug option field **736***a* of the objects table indicates that no errors are to be logged at the object level; input messages should be logged in hex format at the application server, a time stamp should be logged at the security server and output messages should be logged in hex format at the Web server **32**.

This system of logging is very advantageous. Because all logging parameters are defined at the object level, the system administrator can select in a relatively easy manner a very detailed logging for security sensitive transactions. Additionally, using the logging method specified, a system administrator may specify a very detailed level of information to be recorded for debugging purposes.

Message Formats

Referring to FIG. **11**, a table **1100** shows the formats of the messages delivered between systems of the network security system **10**. Table **1100** shows the various fields that may be included and messages delivered according to the messaging protocol of the present invention. Table **1100** also includes sample data that may be included in a field and indicates what information is included in the particular messages as delivered according to the system of the present invention. While many fields are available for use, not all fields are relevant or used in each transaction between systems of the network security system **10**. The selected fields included in various messages include FromNode field **1104**, a FromTime field **1106**, a FromCodePage field **1108**, a FromByteOrdering field **1110**, a FromPlatform field **1112**, a FromDataMode field **1114**, a Password field **1116**, a LogOption field **1118**, a DebugOption field **1120**, a UserName field **1122**, a UserPassword field **1124**, a UserID field **1126**, a Sequence number field **1128**, an Object field **1130**, a PublicKey **1132**, a TargetSocket field **1134**, a TargetAddress field **1136**, a ReturnCode field **1138**, a GatewayData field **1140**, an ObjectData field **1142**, and an EndData field **1144**. A GatewayData field **1140** contains information specific to the Web server. The ObjectData field contains information supplied by the browser **39** and End of Data or End of Record codes. The target socket field contains the node number used by the web server **32** to communicate

with the security server **24**. Return codes of ReturnCode field **1138** are used to communicate error conditions.

The FromCodePage field **1108** specifies whether ASCII or EDCBIC is used as discussed above. The ByteOrdering field **1110** specifies whether the big or little Endian should be used as specified above. The messages column **1107** indicates which fields are included in which messages. A numbers in the message column of FIG. **11** in association with a particular field indicates that that field is included within the message specified in the column and the number associated with the "end" field indicates the total number of fields included in each message.

Processes of Present Invention Referring to FIGS. **12***a*, **12***b*, **12***c*, **12***d* and **12***e*, the processes implemented in the preferred embodiment of the present invention are described. At step **1202**, if the Gateway component is executing as a CGI Gateway to a web server, the user's request is initiated from a web browser or from a JAVA applet. After a user has invoked a web browser or JAVA applet, the user enters the address of the web sever at step **1204** which initiates access to the computer systems of the present invention. At step **1206**, the transactions or object options for selection are presented to a user. The process then proceeds to step **1208** where a user enters a user name and password. The user name and password could also be provided by the JAVA applet or HTML code. The user may then activate or request that an object for transaction be executed at step **1212**. At step **1214**, the web server **32** determines that the information input should be passed to the security server **24**. Before sending a message to the web server **24** that includes the information input by the user, the web server **32** encrypts, at step **1216**, the message and includes a digital signature in the message for authentication and data integrity purposes. It should be appreciated that a variety of encryption methods as known by those skilled in the art may be used such as DES, Triple DES, DESX, RC2, RC4, RC5, IDEA, or RSA. The web server **32** then sends at step **1218** the encrypted message to the security server **24**.

Referring to FIG. **12***b*, the processes occurring at the security server **24** are described. At step **1222**, a security server receives and decrypts the message sent from the web server **24**. At step **1224**, the security server **24** checks whether the message came from an appropriate source by verifying that the digital signature is correct. The process then proceeds to step **1226** where the authorization check for the user transactions begin. At step **1226**, the user tables stored in the transaction tables database are accessed. The process then proceeds to step **1230** where a determination is made whether the user has entered an authorized user name and valid password. If at step **1230**, the user did not enter a valid user name or valid password, the process proceeds to step **1232** where the transaction is aborted. If the user did enter a valid user name and valid password, the process proceeds to step **1234**. At step **1234**, the object tables are accessed to determine whether the object or transaction selected by the user is available. At step **1236**, the process determines if the object name is in the object table. If the object name is not in the object table, the process proceeds to step **1238** where the transaction is aborted.

If, however, the object is in the object table, the process proceeds to step **1240** (FIG. **12***c*) where the roles tables are accessed to determine whether the user is authorized to access this object to perform the transaction. At step **1242**, the process determines whether the user is authorized to do the transaction indicated as determined from the roles tables. If the user is not authorized to perform the specific transaction, the process proceeds to step **1244** where the transaction is aborted. If, however, at step **1242**, the user is authorized to perform the transaction, the process proceeds to step **1246** where the nodes tables are accessed. At step **1248**, the process determines whether the node designated for the transaction is available and may be accessed during the current time period. If the node is not available to be accessed during the current time period, the process proceeds to step **1250** where the transaction is aborted.

If, however, the node may be accessed during the current time, the process proceeds to step **1252**. At step **1252**, a public encryption key is generated for this particular transaction. At step **1254**, a port number is randomly generated from the available ports. The port number generated from this randomizing routine is used as the port on which communications are to occur between an object and a web server. The process then proceeds to step **1256** (FIG. **12***d*) where communication set-up data is delivered. At step **1256**, the security server **54** sends a transaction information, the public key for this transaction, the random port number for this transaction, and the duration value for the transaction to the object manager of the application server. The process then proceeds to step **1257** where the object manager may initiate execution of the object. At step **1258**, the object manager of the application server notifies the security server **24** that the object has begun execution.

At step **1260**, a security server **24** additionally sends a new public key, the port number, and the random node location to the web server **32**. By generating a new public key for each transaction and separately sending these keys to the two systems that are to communicate, the security system **10** of the present invention provides a security protocol that is difficult for a computer hacker to break.

At step **1262**, the current object execution time for the transaction is compared against the time limit for the transaction. If the current duration for the transaction exceeds the time-out period at step **1266**, the process proceeds to step **1268** where the transaction is aborted. However, if at step **1266**, the transaction duration has not exceeded the time-out value, the process proceeds to step **1270***a*. At step **1270***a*, a parallel process is initiated: at step **1270***b* a time monitor is initiated to monitor the execution time of the object and at step **1271** a program routine waits for completion of the execution of the object. If the actual execution time of the object exceeds the time-out value, the process proceeds to step **1268** where the transition is aborted. In parallel with process **1270***b*, the system proceeds to step **1271** and waits for the object to complete execution. The line **1259** indicates that the process waits on a response from the object when the object begins execution. When the object completes execution and provides the needed information, the process proceeds to step **1272** (FIG. **12***e*). When the object has finished executing, the object encrypts, at step **1272**, the data message with the private key for this transaction. At step **1274**, the object outputs the transaction response on the random port supplied by the security server so that the object response is available to the Web server. The process then proceeds to step **1276**. The gateway of the web server may then listen on the port supplied by the security server for this particular transaction. The executed transaction is displayed to the user at step **1278**. The process then ends at step **1280**.

The foregoing relates to the preferred embodiment of the present invention, and many changes may be made therein without departing from the scope of the invention as defined by the following claims.

What is claimed is:

1. A method for providing a first computer with secure access to a destination computer, comprising the steps of:

receiving a first message from the first computer at a gateway requesting a function to be executed by the destination computer;

directing the first message from the gateway to a security server;

determining whether the requested function is permitted;

if the requested function is permitted, transmitting a second message from the security server to the destination computer authorizing execution of the function;

initiating execution of the function at the destination computer; and

while the function executes, asynchronously transmitting a third message from the destination computer to the security server confirming initiation of the execution of the function.

2. The method of claim **1** further comprising the step of:

transmitting a fourth message from the security server to the gateway while the function executes.

3. The method of claim **2** further comprising the steps of:

randomly selecting a communications port from a plurality of unused communications ports available at the gateway;

including a value representing the selected communications port in the second message transmitted from the security server to the destination computer;

including the value representing the selected communications port in the fourth message transmitted from the security server to the gateway;

preparing the gateway to receive communications from the destination computer on the selected communications port; and

after the function has finished executing, transmitting a fifth message from the destination computer to the selected communications port of the gateway, the fifth message including a response associated with the executed function.

4. The method of claim **2** further comprising the steps of:

allotting a predetermined function execution time;

including a value representing the predetermined function execution time in the second message transmitted from the security server to the destination computer; and

terminating execution of the function if the time to execute the function exceeds the predetermined function execution time.

5. The method of claim **4** further comprising the step of logging the termination of the execution of the function in a log maintained at the security server.

6. The method of claim **4** further comprising the step of including the value representing the predetermined function execution time in the fourth message transmitted from the security server to the gateway.

7. The method of claim **2** further comprising the steps of:

dynamically creating a single-use encryption key;

transmitting the single-use encryption key in the second message transmitted from the security server to the destination computer;

transmitting the single-use encryption key in the fourth message transmitted from the security server to the gateway;

encrypting a fifth message with the single-use encryption key at the destination computer, the fifth message including a response associated with the executed function; and

decrypting the fifth message at the gateway using the single-use encryption key.

8. The method of claim **1**, wherein the step of determining whether the requested function is permitted comprises one or more of the steps selected from the group including:

accessing a first table to determine whether the user has input identification information contained in the first table;

accessing a second table to determine whether the user is authorized access to an indicated program module of the destination computer;

accessing a third table to determine whether the user has access privileges for the requested function;

accessing a fourth table to obtain a physical address associated with the destination computer; and

determining whether the requested function has been requested during a time when the destination computer is available for performing the requested function.

9. The method of claim **1**, wherein the first message is encrypted and contains a digital signature to authenticate the first message was received from an authorized first computer, further comprising the steps of:

decrypting the first message;

receiving the digital signature in the first message; and

authenticating the first message by calculating a digital signature associated with the first message and comparing the calculated digital signature to the received digital signature.

10. The method of claim **1**, wherein the step of executing the function comprises executing an object or completing a transaction.

11. An apparatus configured to perform the method of claim **1**.

12. A computer storage medium, or a group of computer storage media, comprising computer-executable instructions for performing the method of claim **1**.

13. A method for providing a first computer with secure access to a destination computer, comprising the steps of:

receiving a first message from the first computer at a gateway requesting a function to be executed by the destination computer;

directing the first message from the gateway to a security server;

determining whether the requested function is permitted;

if the requested function is permitted, transmitting a second message from the security server to the destination computer authorizing execution of the function;

initiating execution of the function at the destination computer;

allotting a predetermined function execution time;

including a value representing the predetermined function execution time in the second message transmitted from the security server to the destination computer;

terminating execution of the function if the time to execute the function exceeds the predetermined function with execution of time while the function executes, asynchronously transmitting a third message from the destination computer to the security server confirming initiation of the execution of the function.

14. The method of claim **13** further comprising the steps of:

while the function executes, asynchronously transmitting a fourth message from the security server to the gateway;

dynamically creating a single-use encryption key;

transmitting the single-use encryption key in the second message transmitted from the security server to the destination computer;

transmitting the single-use encryption key in the fourth message transmitted from the security server to the gateway;

encrypting a fifth message with the single-use encryption key at the destination computer, the fifth message including a response associated with the executed function;

after the function has finished executing, transmitting the fifth message from the destination computer to the selected communications port of the gateway, the fifth message including a response associated with the executed function; and

decrypting the fifth message at the gateway using the single-use encryption key.

15. The method of claim **14**, wherein the step of determining whether the requested function is permitted comprises one or more of the steps selected from the group including:

accessing a first table to determine whether the user has input identification information contained in the first table;

accessing a second table to determine whether the user is authorized access to an indicated program module of the destination computer;

accessing a third table to determine whether the user has access privileges for the requested function;

accessing a fourth table to obtain a physical address associated with the destination computer; and

determining whether the requested function has been requested during a time when the destination computer is available for performing the requested function.

16. An apparatus configured to perform the method of claim **14**.

17. A computer storage medium, or a group of computer storage media, comprising computer-executable instructions for performing the method of claim **14**.

18. A method for providing a first computer with secure access to a destination computer, comprising the steps of:

receiving a first message from the first computer at a gateway requesting a function to be executed by the destination computer;

directing the first message from the gateway to a security server;

determining whether the requested function is permitted;

if the requested function is permitted:

dynamically creating a single-use encryption key,

transmitting a second message from the security server to the destination computer authorizing execution of the function, and

including the single-use encryption key in the second message;

initiating execution of the function at the destination computer;

while the function executes:

asynchronously transmitting a third message from the destination computer to the security server confirming initiation of the execution of the function,

asynchronously transmitting a fourth message from the security server to the gateway, and

including the single-use encryption key in the fourth message; and

after the function has finished executing:

encrypting a fifth message with the single-use encryption key at the destination computer, the fifth message including a response associated with the executed function,

transmitting the fifth message from the destination computer to the selected communications port of the gateway, the fifth message including a response associated with the executed function, and

decrypting the fifth message at the gateway using the single-use encryption key.

19. An apparatus configured to perform the method of claim **18**.

20. A computer storage medium, or a group of computer storage media, comprising computer-executable instructions for performing the method of claim **18**.

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